Low-Cost Weather Satellite Images

Picture Transmission

Don Hillger and Garry Toth

For decades, satellite images have been beamed to the ground and made available to those with low-cost receiving equipment through the *Automatic Picture Transmission* (**APT**) system. The system was designed to provide real-time, low-spatial-resolution weather satellite images from analog signals. On the other hand, full-resolution images are delayed until the satellite passes over ground stations with the appropriate receiving equipment. This is necessarily more complex and more expensive than **APT** receiving equipment.

The first **APT** system was carried as a payload on *TIROS-8* launched in 1963, and continued as a service on subsequent *TIROS*, *ESSA*, *ITOS*, *NOAA*, and the first two of NASA's *Nimbus* series of weather satellites. Beginning in 1972 the **APT** system was also carried on the Russian weather satellites starting with *Meteor-1-11*. The most recent *NOAA-18* launched in 2005 still had **APT** on board, as will *NOAA-19* yet to be launched. Thus the **APT** service will be available into the 2010s. However the **APT** system will change in the future to a digital format called the *Low Rate Picture Transmission* (**LRPT**) on satellites that will replace the *NOAA* series.

The current **APT** system provides low-resolution analog images from data provided by the *Advanced Very High Resolution Radiometer* (**AVHRR**) carried by *NOAA* satellites. Two channels are continuously transmitted using analog VHF signals. These channels are a visible image and an infrared image during the day and two different infrared images at night. This allows the use of simple, low-cost ground equipment for **APT** reception.

An **APT** satellite image consists of lines that come from a scan of the earth. Successive scans are made as the satellite moves in its orbit. In polar orbits, the satellite is within view of an earth receiver for only about 15 minutes. The time will be less if the satellite does not pass directly overhead. The higher the satellite is in the sky above the receiver, the stronger the signal and the better the data reception. The **APT** system was designed with these constraints in mind.

Two APT Cameras On *ESSA-8* Provided Weather Reports For *Apollo-8* Astronauts

Shown above is a December 15, 1968, launch cover of *ESSA-8* that provided launch and recovery weather reports for *Apollo-8* using two **APT** cameras covering a 2,000 mile range. The *Apollo-8* astronauts are also pictured on this cover.

There are three stamps that show **APT**-like images. Dominica issued a stamp (1973/*Scott* 359) that pictures what appears to be a 35mm film with an image of clouds associated with a hurricane over the Gulf of Mexico. Several land and ocean features can also be identified such

Gulf Of Mexico Hurricane Shown On This APT Image Dominica (*Scott* 359)

Photograph Of Storm Added To Sun God Demeter Image Grenada (*Scott* 496)

as the Yucatan peninsula and Cuba. To the south of the Yucatan we see the land surfaces of Honduras, Nicaragua, and Costa Rica.

A similar **APT**-like image is found on a stamp issued by Grenada (1973/*Scott* 496). A photograph has been added to the image of the sun god Demeter to show the island of Grenada and its capital St. George on the west coast. With the large size of this relatively small island, it's less likely that it represents a low-spatial-resolution **APT** image; instead, it may be the higher-spatial-resolution image from which an **APT** signal was derived.

A third **APT**-like image is found on a stamp issued by Hungary (1973/*Scott* 2019). The satellite image shows clouds in a tight spiral with a low pressure system at the very center. Also pictured is the *Interkosmos-1* (**IK1**) satellite sending images to a helical **APT** antenna. A large number of postal items depict such antennas. The **IK** series is not known to have carried **APT** transmitters, but this satellite

Satellite Sends Images To Helical APT Antenna Hungary (*Scott* 2019)

Large Helical APT Antenna Receives Image Of Cloud East Germany (*Scott* 983)

that was launched in 1969 might have served as the platform for testing the first Soviet **APT** systems.

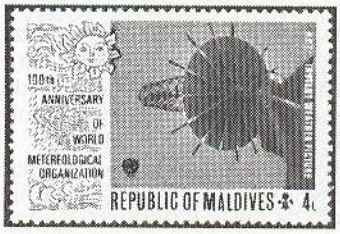
APT Antennas

The most common **APT** antenna is either helical or corkscrew-shaped. The helical antenna allows reception of the right-hand circular-polarized **APT** signals transmitted by the satellite. Communications antennas that use single-plane polarization will lose the signal when the transmitter and receiver are not in the same orientation. **APT** systems use circular polarization to overcome this problem.

Another advantage is that unwanted signals reflected off nearby objects are rejected by the **APT** system. Since circular-polarized signals occupy all planes, they undergo less signal loss due to absorption than other types of signals. East Germany issued a stamp (1960/*Scott* 983) showing a large helical **APT** antenna pointing skyward. The stamp also pictures a drawing of clouds in a large spiral around a low pressure system over Europe.

An issue by Kenya, Uganda, and Tanzania (1973/*Scott* 262) shows another helical **APT** antenna pointed toward a

This Helical APT Antenna Is Positioned Manually Kenya, Uganda, And Tanzania (*Scott* 262)



Antenna Moved By Motors Rather Than Manually
Maldives (*Scott* 467)

TIROS/ESSA satellite. In this case a man is manually moving the antenna while listening to the satellite signal on headphones. Even large antennas can be finely balanced so that an operator can easily point the antenna in the right direction.

Most polar-orbiting weather satellites fly over a given location at about the same time of day. However, since there is not an even number of orbits per day, the satellite overpass varies from day to day. Thus a tracking station must know the orbit in order to track the satellite with the antenna and receive the **APT** signal. Omnidirectional **APT** antennas also exist. They do not need to be moved to follow the satellite. However, the authors have found no such antennas on postal items.

A Maldive Islands issue (1973/*Scott* 467) shows yet another helical **APT** antenna. This one appears to be driven by motors rather than by hand. The orbit of the **APT**-equipped satellite can be determined either manually or with a computer. The resulting coordinates are then used to position the antenna. In either case, the satellite orbital elements and a recent equator crossing longitude are used to plot future satellite orbits. That, along with knowledge of the **APT** receiver's location and the satellite's orbital geometry, indicates where to point the antenna as the satellite flies over.

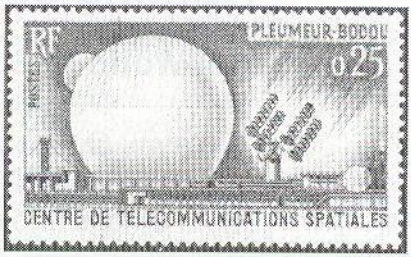
Yagi-Uda Antenna Receives Image From *ITOS* Satellite
Vietnam (*Scott* 447)

Antenna With Four Yagi-Udas Receive Images From Balloons
Russia (*Scott* 4898)

Another type of **APT** antenna is shown on a Vietnam stamp (1973/*Scott* 447). Instead of a helical design, the antenna uses a a directional antenna that defines the path of maximum signal strength. This antenna is called the *Yagi-Uda* antenna; it is named after **Hidetsugu Yagi** and **Shintaro Uda** of Japan who jointly invented it in 1926. On this stamp, the **APT** antenna points toward an *ITOS* satellite. We also see a drawing of the cloud pattern around a typhoon with a small dot indicating the eye.

There are also multiple versions of the single *Yagi-Uda* antenna. These are also higher-gain antennas, and many of them are associated with the reception of the signals from balloon-borne instrumentation. One of the best representations occurs on a stamp issued by Russia (1981/*Scott* 4898). It shows an antenna with four *Yagi-Udas*, but they are not crossed so they are not for receiving circular-polarized **APT** signals.

Finally, a number of postal items show multiple-helix antennas. These look somewhat like single-helix **APT** antennas but are not for **APT**. One of the best phil-



Four-Helix Antenna Next To Dome At Ground Station
France (*Scott* 1047)

atelic examples of a multiple-helix antenna is found on a stamp issued by France (1962/*Scott* 1047). The four-helix antenna, pointing skyward, sits next to a dome at the Pleumeur-Bodou telecommunications ground station.

As we have seen, the various elements of **APT** systems are well represented on postal items. The popularity of these inexpensive images ensures that the **APT** system will continue into the future, even though the format will change from analog to digital and the name will change accordingly.

For a checklist of postal items referring to APT systems, see the authors' webpage at <*http://www.cira.colostate.edu/ramm/-hillger/apt.htm*>. The authors would be interested in hearing from readers who may know of additional postal items related to the **APT** system.•

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